NORTH ATLANTIC TREATY ORGANIZATION
ORGANISATION DU TRAITE DE L'ATLANTIQUE NORD

MILITARY AGENCY FOR STANDARDIZATION (MAS)
BUREAU MILITAIRE DE STANDARDISATION (BMS)
1110 BRUSSELS

21 August 2001 MAS/0993-PPS/4225

See AC/310 STANAG distribution

STANAG 4225 PPS (EDITION 2) – THE SAFETY EVALUATION OF MORTAR BOMBS

References:
a. AC/310-D/165 dated 24 February 1999
b. MAS/348-MMS/4225 dated 12 November 1990 (Edition 1)

1. The enclosed NATO Standardization Agreement which has been ratified by nations as reflected in page (iii) is promulgated herewith.

2. The references listed above are to be destroyed in accordance with local document destruction procedures.

3. AAP-4 should be amended to reflect the latest status of the STANAG.

ACTION BY NATIONAL STAFFS

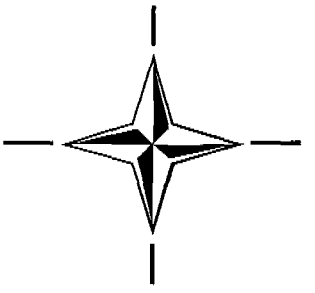
4. National staffs are requested to examine page (iii) of the STANAG and, if they have not already done so, advise the Defence Support Division through their national delegation as appropriate of their intention regarding its ratification and implementation.

Jan H ERIKSEN
Rear Admiral, NONA
Chairman, MAS

Enclosure:
STANAG 4225 (Edition 2)

STANAG No. 4225
(Edition 2)

NORTH ATLANTIC TREATY ORGANIZATION (NATO)



MILITARY AGENCY FOR STANDARDIZATION (MAS)

STANDARDIZATION AGREEMENT (STANAG)

SUBJECT: THE SAFETY EVALUATION OF MORTAR BOMBS

Promulgated on 21 August 2001

Jan H ERIKSEN
Rear Admiral, NONA
Chairman, MAS

STANAG 4225
(Edition 2)

RECORD OF AMENDMENTS

No.	Reference/Date of amendment	Date entered	Signature

EXPLANATORY NOTES

AGREEMENT

1. This NATO Standardization Agreement (STANAG) is promulgated by the Chairman MAS under the authority vested in him by the NATO Military Committee.

2. No departure may be made from the agreement without consultation with the tasking authority. Nations may propose changes at any time to the tasking authority where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

DEFINITIONS

4. Ratification is "In NATO Standardization, the fulfilment by which a member nation formally accepts, with or without reservation, the content of a Standardization Agreement" (AAP-6).

5. Implementation is "In NATO Standardization, the fulfilment by a member nation of its obligations as specified in a Standardization Agreement" (AAP-6).

6. Reservation is "In NATO Standardization, the stated qualification by a member nation that describes the part of a Standardization Agreement that it will not implement or will implement only with limitations" (AAP-6).

RATIFICATION, IMPLEMENTATION AND RESERVATIONS

7. Page (iii) gives the detalls of ratification and implementation of this agreement. If no details are shown it signifies that the nation has not yet notified the tasking authority of its intentions. Page (iv) (and subsequent) gives details of reservations and proprietary rights that have been stated.

FEEDBACK

8. Any comments concerning this publication should be directed to NATO/MAS - Bvd Leopold III - 1110 Brussels - BE.

STANAG 4225
(Edition 2)

NAVY/ARMY/AIR

NATO STANDARDIZATION AGREEMENT (STANAG)

THE SAFETY EVALUATION OF MORTAR BOMBS

Annexes:

A. Safety of Propellant Trial.
B. Strength of Design Trial.
C. Freedom from Premature and Early Burst Trial.
D. Other Mandatory Safety Trials.
E. Mortar Ammunition Double Loading Test (Non Mandatory).

Related Documents:

STANAG 2895	Extreme Climatic Conditions and Derived Conditions for Use in Defining Design/Test Criteria for NATO Forces' Materiel.
STANAG 4110	Definition of Pressure Terms and their Inter-relationship for Use in the Design and Proof of Cannons and Ammunition.
STANAG 4157	Development of Safety Test Methods and Procedures for Fuzes for Unguided Tube Launched Projectiles – AOP-20.
STANAG 4170	Principles and Methodology for the Qualification of Explosive Materials for Military Use.
STANAG 4239	Electrostatic Discharge, Munition Test Procedures – AOP-24.
STANAG 4324	Electromagnetic Radiation (Radio Frequency) Test Information to Determine the Safety and Suitability for Service of EEDs and Associated Electronic Systems in Munitions and Weapon Systems.
STANAG 4375	Safety Drop, Munition Test Procedures.
AOP-15	Guidance on the Assessment of the Safety and Suitability for Service of Munitions for NATO Armed Forces.

AIM

1. The aim of this agreement is to establish a uniform method for safety evaluation of mortar bombs and to avoid unnecessary duplication of testing by a non-developing nation.

AGREEMENT

2. Participating nations agree that the analysis and test results required to assess the safety of the test item will be provided by the developing nation. Further, they agree that safety testing (including adequate documentation) performed in accordance with this STANAG shall be acceptable to the ratifying nations.

DEFINITIONS

3. In this STANAG the following definitions are assumed to be agreed:

a. **Mortar Bomb.** The term 'mortar bomb' means the complete munition, comprising projectile and charge. The projectile normally comprises fuze, body filled with HE or other filling, obturator, and tail assembly.

b. **Pressure Terms.** The pressure related terms and definitions used in this document conform to STANAG 4110 (Edition 2) and are, as appropriate, defined below.

c. **Lower Conditioning Temperature (LCT).** The LCT is the temperature to which test items are conditioned for cold tests. This temperature is based on the climatic region that the testing nation and the using nations predict to be the worst-case cold environment that the test item will encounter during storage and transportation. (See Table 1.)

d. **Lower Firing Temperature (LFT).** The LFT is the temperature to which test items are subjected for cold test firing. This temperature is based on the climatic region that the testing nation and the using nations predict to be the worst-case cold environment that the test item will encounter during operations. (See Table 1.)

e. **Upper Conditioning Temperature (UCT).** The UCT is the temperature to which test items are conditioned for hot tests. This temperature is based on the climatic region that the testing nation and the using nations predict to be the worst-case hot environment that the test item will encounter during storage and transportation. (See Table 1.)

f. **Upper Firing Temperature (UFT).** The UFT is the temperature to which test items are subjected for hot test firing. This temperature is based on the climatic region that the testing nation and the using nations predict to be the worst-case hot environment that the test item will encounter during operations. (See Table 1.)

g. **Mortar Safe Maximum Pressure (SMP) Curve.** The mortar SMP curve is a pressure against location curve which specifies, as a result of design, the particular value of pressure at each point along the barrel which, if exceeded, could result in the occurrence of permanent deformation.

h. **Mortar Design Pressure (DP) Curve.** The mortar DP curve is a pressure against location curve which specifies the particular value of pressure at each point along the barrel which statistically should not be exceeded by more than one round in 1,000,000 rounds under Extreme Service Conditions (ESC).

i. **Margin of Safety.** The margin of safety is the difference between the mortar SMP curve and the mortar DP at any point along the barrel.

j. **Mortar Permissible Maximum Pressure (PMP) Curve.** The mortar PMP curve is the pressure against location curve which specifies the pressure at each point along the barrel which, for reasons of safety, should not be exceeded statistically by more than 13 rounds in 10,000 under ESC.

k. **Maximum Operating Pressure (MOP) Curve.** This is the curve derived from the pressures generated at each point in a specified mortar barrel by a specified charge under the most ESC which will not be exceeded statistically by more than 13 rounds in 10,000. The extreme conditions normally occur at the UFT in a new barrel with the

heaviest permissible weight of projectile. An allowance is made for occasion to occasion, barrel to barrel, lot to lot, and round to round variations. The MOP, which is derived by firing, is compared with Mortar PMP (or Projectile PMP if this is lower) in order to determine whether a particular charge design is likely to produce unsafe pressures in relation to the strength of design of the mortar or mortar bomb.

l. **Mortar Proof Pressure (PP).** The mortar PP is that pressure, within specified tolerances, at which a mortar is proofed. The maximum mortar PP is to be the mortar DP; the minimum mortar PP should be the mortar PMP.

GENERAL

4. Concept of Safety Evaluation. The assessment of munition safety is a continuous process. Initially, it is necessary to establish that the design is inherently sound, and to develop test data to show that it is safe for operational use. If the item is accepted for service and enters production, it becomes necessary to establish that changes which may be made in order to simplify production, and the production processes themselves, have not compromised the safety of the design. Finally, as product improvements are planned for introduction into the production line, it must be verified that the improved item is as safe as its predecessor.

5. Procedures.

a. Each nation will be responsible for the safety evaluation of ammunition to be used by its own services and, for this purpose will require copies of the design parameters, safety analyses and trial reports of the nation developing the ammunition to be evaluated. The nations carrying out the safety evaluation trials on a particular munition agree to make their design parameters, safety analyses, and trials reports available to other NATO nations on request.

b. Notwithstanding the intention to avoid duplication of testing, each nation reserves the right to carry out additional testing if considered necessary, and when necessary, to bear the financial, technical and safety consequences of so doing. Nations requiring the additional tests may obtain assistance, under conditions to be negotiated, from the developing nation.

c. Any significant proposed change to the agreed safety evaluation procedures will be provided to the user nations for comment and concurrence; any changes made without the mutual acceptance of the ratifying nations may negate the acceptability by the user nations of the agreed safety evaluation procedures.

d. There are some inherently different environmental hazards and operational philosophies which affect safety evaluations. A specific test programme need not be limited to, or include all the tests described in this document. The selection of tests and test parameters shall be based on the measured or analytically determined life cycle environmental profile of the test item, as indicated in AOP-15.

e. No individual test or group of tests should be assessed in isolation and it is agreed that the final safety evaluation recommendation takes account of development trials as well as the individual national safety evaluation procedures in order to make a valid assessment of the munition in its expected service life environment.

6. Review of Design Information. A review of all information related to the munition under test should be conducted to establish the basis upon which to start planning such testing as may be necessary to gain the remainder of the evidence required to conduct a full appraisal of safety. The schedules in this document are based on the assumption that a satisfactory basis of design data is available, leading to satisfactory assurances of performance.

7. Extreme Service Conditions.

a. Testing is to be carried out at temperatures representative of the extreme conditions likely to be encountered in service. The Climatic Categories in which the ammunition is to be used, and has been designed for, are to be specified by the nation developing the ammunition. The temperature range and diurnal cycles for the various Climatic Categories are given in STANAG 2895. The extreme conditioning and firing temperatures to be used during safety testing are derived from these and are given below:

Climatic Category	Conditioning Temperature °C	Firing Temperature °C
(a)	(b)	(c)
A1	71	71
A2	63	63
A3	58	58
B3	71	71
C1	-33	-33
C2	-46	-46
C3	-51	-51

Table 1

b. The LCT and UCT are used for conditioning stores prior to such tests as drop, bounce, vibration, etc.

c. In this STANAG reference is made to the service UFT etc. This is to indicate the relevant temperature from Table 1 relative to the agreed climatic category in which the mortar bombs are to be used in service.

However, nations reserve the right to conduct testing to standards more severe than specified. In which case, the developing nation should be consulted in the event that a more severe test is specified, in case the test is outside the specified design parameters of the ammunition.

8. Scope and Contents. This document is concerned with the safety evaluation of mortar bombs, and comprises the following 5 Annexes:

a. Annex A: Safety of Propellant Trials.

b. Annex B: Strength of Design Trials.

c. Annex C: Freedom from Premature and Early Burst Trials.

d. Annex D: Other Mandatory Safety Trials.

e. Annex E: Non-Mandatory Double Loading Trials.

A safety assessment of a new design should include all the safety trials in this document as specified. A reduction in the extent and severity of testing may be accepted for mortar bombs of proven design incorporating a minor design change. Any tests not included in this document which are considered necessary by the testing nation will be carried out in accordance with the national document concerning the severity and methods of the test.

9. The Scope of the Testing. The testing is concerned with the safe functioning of the munitions rather than with their operational effectiveness, and is based on an identification of all hazards associated with handling, transportation, launching, and flight to the target. Each component of the bomb is considered: its contribution to launch and flight hazards is assessed, and its compatibility with the complete bomb. Tests may reveal that a hazard exists unless some limitation is imposed in service, for example, on temperature, shock or vibration levels. The overall safety evaluation comprises the following elements:

a. **Transportation, Rough Handling and Storage Safety**. The Freedom from Premature and Early Burst Trial (Annex C) subjects bombs to a sequential environmental trial representing transportation, rough handling and storage. An additional associated mandatory safety trial is the Safety Drop Trial, which determines whether ammunition is safe to handle and dispose of when dropped from 12 m in its packaging. The bomb will be considered safe for transportation, handling and storage under the conditions at which it was tested, provided that during these tests no mortar bombs become unsafe and all bombs fired meet the safety requirements stated in paragraphs 9.b. and 9.c. below. The tests used will be selected to simulate the whole life service environment as defined by the User. Storage life assessment may be given by analogy with a proven munition, but more usually will require specific accelerated storage life trials.

b. **Firing Point Safety**. Firing point safety may be demonstrated by 2 further tests:

(1) Cook-off. The User's required rates of fire will lead to certain barrel temperatures being reached within the mortar. Cook-off trials are conducted to determine the hazards associated with the effect of these temperatures on a bomb loaded in the mortar. The trials concern both propellants and projectiles.

(2) Double Loading Tests. One of the known hazards with mortars is the effect of firing a mortar which has been double loaded. In the case of mortars with fixed firing pins this is only likely to happen where a misfire or hangfire occurs and a second bomb is loaded before the departure of the first. Trials have shown that, as far as design safety is concerned, the problem relates more to the design, particularly the configuration, of the fuze. Accordingly, appropriate tests are included in STANAG 4157. As far as the design of the projectile and charge system is concerned, some nations may consider it desirable to carry out trials to determine:

(a) Whether the HE filling contributes to the effect of a double loading incident.

(b) For each charge level, the pressures generated in the barrel in a double loading situation, in order to be able to determine at which charge level any specific mortar barrel is likely to burst in a double loading incident.

In order to achieve standardization where such tests are to be conducted, a non-mandatory Test Procedure is published at Annex E.

c. **Launch Safety.** The projectile will be considered launch-safe if no premature functions occur whether in-bore or within the arming limits of the fuze (Annex C). An in-bore premature is defined as any functioning of the projectile while it is inside the weapon. Also the maximum pressure developed in the mortar barrel in service firing under the most demanding conditions must be compatible with the design limits of the mortar and the bombs (Annexes A and B).

d. **Flight Safety**. The projectile will be considered flight-safe if no early detonation occurs after fuze arming and before the end of the intended flight (Annex C). In addition, there must be no unintentional material parts separation, detonation or evidence of erratic flight (Annex B). This includes the effect of a wet charge (Annex A).

It is suggested that, due to the fundamental nature of the 12 m Drop Trial, it would be expedient to conduct this trial before any other trials specified in this STANAG are carried out.

10. Testing Excluded. The following related testing has been specifically excluded, since it is covered by other STANAGs:

a. **Fuzes.** The safety evaluation of fuzes will be carried out in accordance with STANAG 4157. However, the correct functioning of fuzes with particular mortar bombs is covered in this STANAG (Annex C).

b. **Explosive Materials.** The explosive materials to be used in mortar bombs are to be assessed in accordance with the requirements of STANAG 4170 (Principles and Methodology for the Qualification of Explosives for Military Use). Test data used in such assessments will be held by the National Authority for the country concerned.

c. **Electrical Hazards.** The safety of the bombs from electrostatic discharge (ESD) and radio frequency (rf) hazards will be established by carrying out, as appropriate, EMC tests specified in STANAGs 4239 and 4324 respectively.

11. Non-explosive-loaded Projectiles. The safety of non-explosive-loaded projectiles will be examined, as appropriate, for each of the features prescribed for explosive-loaded projectiles. For launch safety, the significance of a bore incident involving a non-explosive loaded or carrier bomb may be different from one involving a HE bomb. Bore incidents with non-explosive projectiles must also be considered in terms of likelihood that they may produce weapon failures or create a condition that will endanger personnel.

12. Build Standard of the Munitions. It is essential to ensure that the safety evaluation carried out relates to mortar bombs of a known specification and build standard. All ammunition for these trials is therefore required to be accompanied by a formal document, as nationally specified, which certifies that the mortar bombs are manufactured to a certain build standard or drawing number. The document must be authenticated by the nationally approved quality assurance authority at the production factory. No trial is to start until the mortar bombs to be used for the trials have been checked against such a certificate of build standard. The mortar bombs for which a recommendation for safety is finally given must be of a known design specification, verified by a certificate of build standard, and must be representative of the production build standard. On completion of the trial, the certificates of build standard are recorded as a reference in the trial report.

IMPLEMENTATION OF THE AGREEMENT

13. This STANAG is considered implemented by a nation when that nation has:

a. revised or issued applicable national documents to agree with the provision so of the STANAG.

b. issued the necessary orders or instructions to its forces putting the procedures detailed in this agreement into effect.

ANNEX A to
STANAG 4225
(Edition 2)

SAFETY OF PROPELLANT TRIAL

Appendix:

1. Statistical Derivation of MOP.

AIM

1. The aim of the Safety of Propellant Trial is to determine whether the required in-service combinations of propellant charge and projectiles are safe to fire in the mortar, in respect of the performance of the propellant and the internal pressures generated.

PRE-REQUISITE TESTING

2. The Permissible Maximum Pressure Curve for the relevant Mortar (Mortar PMP), established by the developer, is required.

3. The results of development firings should be available, which establish that there is no significant change in barrel pressures or muzzle velocity within:

a. The weight tolerance of the mortar bomb.

b. The filling weight tolerance of the propellant, both primary and augmenting charges.

OUTLINE PLAN

4. Trial Objectives. The following trial objectives need to be met in the test plan in order to achieve the overall aim:

a. To identify any unsafe or unacceptable feature of the propellant charge pressure-time performance across the range of temperatures required in-service.

b. To verify that the time interval between the initiation of the propellant charge and the development of maximum pressure is consistent and within safe limits. Evidence concerning the firing interval is usually obtained during development trials conducted by the Design Authority.

c. To ascertain whether residue, debris and in-barrel burning resulting from firings are likely to cause inadvertent ignition or obstruction of subsequent rounds, or any external fire hazard.

d. To verify that muzzle velocities are sufficiently consistent.

e. To check that muzzle blast over-pressure levels remain within relevant acceptance criteria. (NB: This test is regarded as a preliminary test in order to establish whether or not there is a potential noise hazard with this particular weapon/ammunition combination. If there is, more extensive testing will be required).

f. To check that a mortar bomb with a propellant charge which has become wet under operational conditions can safely be fired.

g. To verify the range and consistency of the mortar bomb.

5. Outline Plan. Firings are carried out in 3 Parts as follows:

a. **Part 1 - MOP Trial**. The MOP trial comprises a firing scheme in which 108 mortar bombs are fired and pressure-time records are made in an instrumented barrel.

b. **Part 2 - Blast Overpressure Trial**. A number of bombs (normally not less than 15) is fired in order to enable recordings of blast over pressure to be made (see Paragraph 4.e. above).

c. **Part 3 - Wet Efficiency Trial**. A sample of 36 bombs is fired in order to compare the performance of wet and dry propellant charges.

TEST PROCEDURE

6. Part 1 - MOP Trial. The MOP trial is to be conducted as follows:

a. **Mortar Bombs**. Inert-filled mortar bombs will normally be used and should be the same weight as the heaviest service projectile, ie within the weight tolerances, intended to be fired with the propellant charge system under test.

b. **Fuzes**. These can be live if suitable firing clearance is available. Alternatively they may be inert or plugs representing fuze (PRF).

c. **Mortar**. The internal dimensions of the pressure barrel must be as nearly as possible the same as those of the service barrel, ie within manufacturing tolerances. The barrel must be provided with tappings along its lengthwise dimension to accept pressure transducers. The number and location of the tappings will depend upon the design of the barrel and its critical features. One tapping must be at the estimated point of maximum pressure, with at least one other tapping above and one below this position.

d. **Propellant**. Three (or more) lots of propellant, where possible representative of production, are required for testing in the form of propellant charges. These charges must be within the specified filling weight tolerance. Ideally, at least one propellant lot should be at the top of the pressure specification.

e. **Charges**. The top service charge is to be used for all firings.

f. **Temperature**. Firings are to be carried out at three temperatures having been conditioned for the durations specified in the Strength of Design Trial (Annex B).

(1) The UFT.

(2) 21°C.

(3) The LFT.

g. **Occasions**. Firings are to be carried out on not less than 2 separate occasions. An occasion is defined as one continuous period of firing during which the mortar is not taken out of action, nor is there any significant change in ambient conditions. A new occasion is defined as when the mortar has been taken out of action for a period of at least 2 hours combined with at least one of the following circumstances:

(1) Another day.

(2) A new location.

(3) A significant change in ambient conditions.

h. **Barrels**. Unless during development trials sufficient evidence has been gathered to establish that barrel-to-barrel variation can be regarded as negligible for the system, firings additional to those detailed in Sub-paragraph j below will be necessary in order to quantify the effect of these variations.

i. **Range and Consistency**. The fall of shot will be recorded to verify the range and consistency for the QE being used, taking account of the effect on range of a fixed pressure barrel.

j. **Firing Scheme**. Mortar bombs are to be fired in accordance with the scheme set out in Table 1. It should be noted that:

(1) Two warmer rounds of the same build standard as the bombs under test should be fired prior to each occasion.

(2) Should warmers of the same build standard be unavailable, one anti-interference bomb of the same build standard as those under test should be fired prior to each occasion, in addition to 2 warmers.

(3) In certain circumstances less than 3 propellant lots might be fired. In this case the mortar bombs allocated to lots B and/or C will be allocated depending on whether 3, 2 or one propellant lot is available. If more than 3 lots are used, extra mortar bombs will be required to ensure that each firing has a minimum of 3 mortar bombs.

Temperature		LFT				21°C				UFT			
Occasions		1	2	3	4	1	2	3	4	1	2	3	4
Propellant Lot	A	3	3	3	3	3	3	3	3	3	3	3	3
	B	3	3	3	3	3	3	3	3	3	3	3	3
	C	3	3	3	3	3	3	3	3	3	3	3	3
Totals		36				36				36			
		108											

Table 1

k. **Records and Observations**. The following are required:

(1) Specifications of ammunition and weapons fired.

(2) Pressure-time recordings for each transducer.

(3) Muzzle velocities.

(4) Ranges and deflections of fall-of-shot.

(5) Meteorological data.

(6) Subjective assessment of residue, debris (including external effects) and any in-barrel burning resulting from firings.

(7) Weights of projectiles as fired.

l. **Data Reduction.** From the pressure time recordings obtained for each transducer location in the barrel and for each round fired, the maximum pressure is recorded. Statistical procedures are then applied to these values to determine, for each transducer location, that value of pressure which, it may be asserted with 95% confidence, will not be exceeded by more than 13 in 10,000 mortar bombs under extreme service conditions, ie the MOP. The statistical procedures to be applied are described in Appendix 1 to this Annex. A curve connecting the single values of MOP for each transducer location can be drawn for the whole barrel. This curve is described as the MOP curve.

m. **Criteria.** The following criteria are applied to the results of firing in Part 1:

(1) The relationship between pressures observed at each transducer location at the LFT and corresponding pressures observed at 21°C and at the UFT must be acceptable and free from anomaly. The highest pressure observed in the barrel must occur at the UFT.

(2) The intervals between initiation of the propellant charges and the development of maximum pressure must be consistent and within safe limits.

(3) The MOP Curve must not exceed the PMP Curve in value for any point in the mortar barrel.

(4) Muzzle velocities and fall-of-shot must show good consistency and meet requirements. A statistical inspection of all relevant development rounds must show that the incidence of short ranging directly attributable to low muzzle velocities is acceptable.

(5) Residue, debris and in-barrel burning resulting from firings should be at a level not likely to cause inadvertent ignition or obstruction of subsequent rounds, or any external fire hazard.

7. Part 2 - Blast Overpressure Trial. Blast overpressure firings are to be conducted as follows:

a. **Mortar Bombs.** Either fully live or inert filled mortar bombs may be used for all firings and should be representative of production.

b. **Fuzes.** Either inert or live fuzes may be used. With a live mortar bomb, live fuzes should normally be used.

c. **Mortar.** A service mortar is to be used. Other barrels may be used, if necessary, provided that they are truly representative if the service barrel and in particular the external shape of the muzzle end of the barrel is the same.

d. **Propellant.** All firings should be conducted using propellant from the same lot, to afford comparable results.

e. **Charges.** Top service charges must be fired. Other charges may also be fired if considered appropriate.

f. **Temperature**. All firings are to be conducted with ammunition conditioned to 21 °C.

g. **Gauges**. The likely head position of each member of the crew at the moment of firings should be established. A gauge for measuring blast overpressures is then placed at each of these positions. The gauges will need to be repositioned for each change of QE. Additional gauges may be positioned in order to allow for variability of head positions, or to enable a polar diagram of blast overpressure to be produced to determine the distance from the mortar at which hearing protection is no longer required, providing that this does not affect the readings on the gauges which represent the crew head positions.

h. **Quadrant Elevation (QE)**. Firings are to be conducted at 3 different QE, at intervals of not less than 200 mils, which are representative of the QE most commonly used in service.

i. **Firing Site.** The area of the firing site should be reasonably level and free from obstruction which could cause reflections.

j. **Firing Scheme.** A minimum of 5 mortar bombs are to be fired at each specified QE, giving a total of not less than 15 mortar bombs.

k. **Records and Observations**. The following are required.

(1) a. Specifications of any ammunition and weapons fired.

(2) Location (in 3 dimensions) and orientation of each gauge.

(3) Blast overpressure traces against time at each gauge position.

(4) Meteorological data.

l. **Criteria**. Blast overpressure levels must lie within relevant national acceptance criteria.

8. Part 3 - Wet Efficiency Trial. Wet efficiency firings are to be conducted as follows:

a. **Mortar Bombs.** Inert-filled mortar bombs will normally be used; these will be of a weight representative of service mortar bombs.

b. **Fuzes**. These can be live if suitable firing clearance is available. Alternatively they may be inert or plug representing fuze (PRF).

c. **Mortar**. Either a service barrel or a pressure barrel which is representative of a service barrel may be used.

d. **Propellant**. In order to afford comparable results, all propellant charges must contain propellant from the same lot which must be representative of production.

e. **Charges**. Firings are to be carried out using both the top and bottom service and also intermediate charges if considered appropriate (see Sub-paragraph h below).

f. **Temperature**. All firings are to be carried out with the bombs (including charges) conditioned to 21 °C.

g. **Occasions**. A complete serial must be fired on one occasion.

h. **Firing Scheme**. The firing scheme for Part 3 is set out in Table 2 below:

Serial	Number of Mortar Bombs	Service Charge	Wet/Dry
(a)	(b)	(c)	(d)
1a	6	Top	Dry
1b	6	Top	Wet
2a	6	Bottom	Dry
2b	6	Bottom	Wet
3a	6	Intermediate	Dry
3b	6	Intermediate	Wet

Table 2

i. **Firing Drill**. Mortar bombs to be fired wet are to have their tails and propellant charges subjected to either of the following:

(1) Immersion in fresh water at 21 °C for 30 seconds.

(2) Exposure to a meteorological 35 knot wind and simulated 150 mm per hour rain, for 30 seconds.

The mortar bombs are then to be transferred directly to the mortar and fired without any attempt being made to disperse the water from the charge. The barrel will be dry swabbed on completion of each wet series.

j. **Records and Observations**. The following are required:

(1) Specifications of ammunition and weapons fired.

(2) Muzzle velocities.

(3) Subjective assessment of residue, debris (including external effects) and in-barrel burning.

k. **Criteria**.

(1) The mean muzzle velocity of mortar bombs with wet propellant charges should not be less than 90%; the muzzle velocity of any individual bomb with a wet propellant charge should be not less than 80% of the mean muzzle velocity of comparable mortar bombs with dry propellant charges, for each service charge fired.

(2) If these criteria are not met, consideration may be given to the adoption of an agreed method of shaking water from the propellant charges after immersion and before loading into the mortar. The firing scheme may then be repeated and the same criteria applied.

(3) After firing each wet series there should be no significant quantity of unburnt propellant left in the mortar.

(4) In any event, residue and debris should be free from signs of unburnt propellant or significant portions of charge container material, which could cause the mortar bomb to stick in the barrel, a slow drop, or ignition of subsequent charges.

Note: Failure to meet these criteria will require that consideration be given to introducing restrictions in use.

Appendix 1 to
ANNEX A to
STANAG 4225
(Edition 2)

STATISTICAL DERIVATION OF MOP

INTRODUCTION

1. This appendix describes:

   a. The initial analysis to determine homogeneity of variances among temperatures. This is necessary in order to guard against erroneous tolerance limits on MOP.

   b. The general statistical model for mortar pressure that underlies the subsequent analysis.

   c. The method of determining a value *m* such that the estimator of the variance of the pressure at a given temperature is approximately distributed as a scalar multiple of a chi-squared variate with *m* degrees of freedom.

INITIAL ANALYSIS

2. For each temperature level (UF, 21°C, LF) a total of 6 mortar bombs will be fired for each combination of propellant lot (3 levels) and occasions (2 levels). By temperature level, calculate the variance of each 6 round group and then pool the variances, thereby obtaining a common variance for each temperature level. Use the Bartlett-Neyman-Pearson test for homogeneity of 3 population variances, with 30 degrees of freedom in each sample (Reference 1). The test is to be performed at the 0.05 level of significance. If a significant result is not obtained, the analysis may continue as outlined in the statistical model below. If a significant result is obtained, then $\log_e$ transform may be tried to stabilize the variance. If the $\log_e$ transform still gives a significant result, then each temperature will have to be analysed separately. These analyses could be accomplished using the procedure outlined below, after omitting the temperature factor. This would result in computing an upper tolerance limit as the critical limit. A flow chart showing in more detail the specific steps in this initial analysis is given in Table 1.

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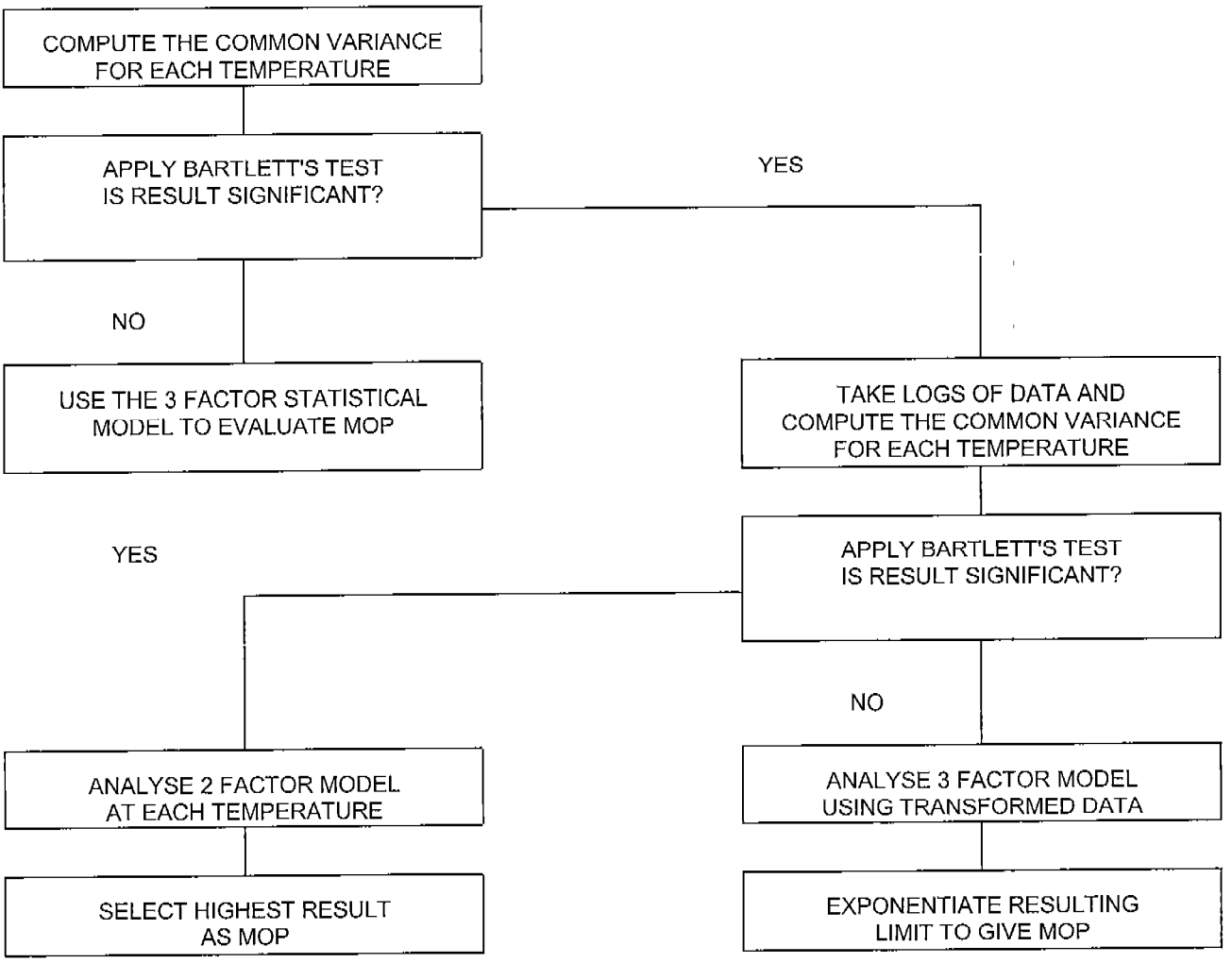

Table 1 - FLOW CHART FOR INITIAL ANALYSIS

STATISTICAL MODEL

3. The general statistical model for the mortar pressure test of the safety of propellant is of the form:

$$x_{ijkl} = A + d_i + b_j + (db)_{ij} + T_k + (dT)_{ik} + (bT)_{jk} + (dbT)_{ijk} + z_{l(ijk)}$$

with i = 1, 2, ...h
j = 1, 2, ...p
k = 1, 2, ...q
l = 1, 2, ...n

where A is a constant
d_i represents the (random) effect of occasion i

b_j represents the (random) effect of batch j
T_k represents the (fixed) effect of temperature k

and where x_{ijkl}, $z_{l(ijk)}$ represent respectively the pressure of the mortar, and the random error for trial l on occasion i with batch j at temperature k All interactions are taken to be random effects; parentheses are used to denote interactions in the model, eg the interaction between batch j and temperature k is denoted by $(bT)_{jk}$..

EXPECTED MEAN SQUARES

4. The expected mean squares can be shown (Reference 2) to be as follows:

Factor	Expectation of Mean Square	Degrees of Freedom
1. Occasions	$\sigma^2 + n\sigma^2_{ijk} + pn\sigma^2_{ik} + qn\sigma^2_{ij} + pqn\sigma^2_{i}$	(h-1)
2. Batches	$\sigma^2 + n\sigma^2_{ijk} + hn\sigma^2_{jk} + qn\sigma^2_{ij} + hqn\sigma^2_{j}$	(p-1)
3. Occasions.Batches	$\sigma^2 + n\sigma^2_{ijk} + qn\sigma^2_{ij}$	(h-1)(p-1)
4. Temperature	$\sigma^2 + n\sigma^2_{ijk} + hn\sigma^2_{jk} + pn\sigma^2_{ik} + hpn\sigma^2_{k}$	(q-1)
5. Occasions.Temps	$\sigma^2 + n\sigma^2_{ijk} + pn\sigma^2_{ik}$	(h-1)(q-1)
6. Batches.Temps	$\sigma^2 + n\sigma^2_{ijk} + hn\sigma^2_{jk}$	(p-1)(q-1)
7. Occasions.Batches.Temps	$\sigma^2 + n\sigma^2_{ijk}$	(h-1)(p-1)(q-1)
8. Residual Error	σ^2	hpq(n-1)

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ESTIMATORS OF VARIANCE COMPONENTS

5. It follows that estimators of the variance components are:

$$\hat{\sigma}_i^2 = \frac{MS_1 - MS_3 - MS_5 + MS_7}{pqn}$$

$$\hat{\sigma}_j^2 = \frac{MS_2 - MS_3 - MS_6 + MS_7}{hqn}$$

$$\hat{\sigma}_{ij}^2 = \frac{MS_3 - MS_7}{qn}$$

$$\hat{\sigma}_k^2 = \frac{MS_4 - MS_5 - MS_6 + MS_7}{hpn}$$

$$\hat{\sigma}_{ik}^2 = \frac{MS_5 - MS_7}{pn}$$

$$\hat{\sigma}_{jk}^2 = \frac{MS_6 - MS_7}{hn}$$

$$\hat{\sigma}_{ijk}^2 = \frac{MS_7 - MS_8}{n}$$

$$\hat{\sigma}^2 = MS_8$$

where MS_r is the mean square for the r^{th} factor in the previous table.

6. When stating individual estimated variance components, those that turn out to be negative shall be replaced by zero.

ESTIMATOR OF A SUM OF VARIANCE COMPONENTS

7. The variance of x_{ijkl} for the k^{th} level of temperature is estimated as:

$$V(x_{ijkl}|k) = \hat{\sigma}_i^2 + \hat{\sigma}_j^2 + \hat{\sigma}_{ij}^2 + \hat{\sigma}_{ik}^2 + \hat{\sigma}_{jk}^2 + \hat{\sigma}_{ijk}^2 + \hat{\sigma}^2$$

$$= \underset{(h-1)d.f.}{\frac{MS_1}{pqn}} + \underset{(p-1)d.f.}{\frac{MS_2}{hqn}} + \underset{(h-1)(p-1)d.f.}{\frac{MS_3}{hpqn}}(hp - h - p) + \underset{(h-1)(q-1)d.f.}{\frac{MS_5}{pqn}}(q-1)$$

$$+ \underset{(p-1)(q-1)d.f.}{\frac{MS_6}{hqn}}(q-1) + \underset{(h-1)(p-1)(q-1)d.f.}{\frac{MS_7}{hpqn}}(q-1)(hp - h - p) + \underset{hpq(n-1)d.f.}{\frac{MS_8}{n}}(n-1)$$

EFFECTIVE DEGREES OF FREEDOM OF THE SUM OF VARIANCE COMPONENTS

8. Denote the coefficient of MS_t by a_t, and the degrees of freedom of MS_t by r_t (t = 1, 2, ..., 8). Then the degrees of freedom m (this may not necessarily be integer) of the approximate χ^2 that corresponds to the distribution of $V(x_{ijkl}/k)$ is estimated (Reference 3) as:

$$\hat{m} = \frac{\hat{V}^2(x_{ijkl}|k)}{\sum_{t=1}^{8}\frac{(a_t MS_t)^2}{r_t}}$$

UPPER TOLERANCE LEVEL ON MORTAR PRESSURE

9. Suppose that we require a confidence 1-α, that not more than a proportion β of rounds exceeds the upper pressure tolerance limit. Then statistical theory (References 4 and 5) shows that the upper pressure tolerance limit is:

$$\bar{x}_{..K.} + (1.05)\lambda.s$$

where $\bar{x}_{..K.} = \max_k \bar{x}_{..k.}$ the highest of the sample mean pressures among the different temperatures;

$$\lambda = \sqrt{\frac{m}{\chi^2_{m,\alpha}}}.r$$

where $\chi^2_{m\alpha}$ is the lower 100.α % point of χ^2_m and r is the solution of

$$\int_{\frac{1}{\sqrt{N}}-r}^{\frac{1}{\sqrt{N}}+r} \phi(t)dt = 1-2\beta$$

where $\phi(t)$ is the standard normal density; N=hpn the number of pressure readings at temperature level K

and $s = \sqrt{\hat{V}(x_{ijkl}/k)}$.

As m is unknown it is replaced by $\hat{m}$ in the formula for λ.

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3. Satterthwaite, F E (1946). An approximate distribution of estimates of variance components. Biometrics, Vol 2, No 6 pp 110-114.

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ANNEX B to
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STRENGTH OF DESIGN TRIAL

AIM

1. To determine whether the structure of a mortar bomb adequately withstands maximum firing stresses.

PRE-REQUISITE TESTING

2. It is necessary that a projectile PMP shall have been established by the developer or a MOP curve calculated as described in Annex A (Safety of Propellant Trial), when the former is not available. It is desirable that this trial should be conducted at pressures based upon PMP, but the use of pressures based on the calculated MOP value is the minimum requirement and is the level quoted in this text. The following information must therefore be available before this trial can be carried out:

a. The maximum value of PMP or MOP.

b. The calculated value of MOP at the LFT, ie the MOP derived from firing at the LFT only.

OUTLINE TRIAL PLAN

3. A sample of 30 bombs, representative of manufacturing production standards (less explosives) is split into 2 equal sub-samples. One sub-sample is preconditioned to the UFT. It is then fired with a special propellant charge which will produce a pressure equivalent to the maximum value of MOP plus 5%. The second sub-sample is preconditioned to the LFT. It is then fired with a special propellant charge which will produce a pressure equivalent to the LFT MOP plus 5%. Checks are made of the weights of mortar bombs fired, and pressures and muzzle velocities achieved. Assessments are based on visual inspection and measurements of bombs before and after firing, on high-speed photography of mortar bombs leaving the muzzle of the mortar, and on radiographic or other techniques of crack detection applied to mortar bombs which have been fired and recovered.

TEST PROCEDURE

4. Sample. Thirty (30) mortar bombs are selected which are representative of the production standard.

5. Fillings. Inert fillings (including inert exploders) and inert-filled fuzes (or suitable plugs) are normally used.

6. Fuzes. Fuzes are not being tested in this Strength of Design Trial. However, inert fuzes (or plugs) must represent the weight of the heaviest fuze to be used in service with the mortar bomb under test.

7. Measurements before firing. External measurements are made of the mortar bomb body diameter at 3 separate locations on the body: at each location the diameter is measured in 2 directions at right angles. External measurements are also made of the length of the mortar body, and of the diameter of the tail boom at a central point. Measurement locations are to be marked so that corresponding measurements can be made after firing. Measurement locations for the mortar bomb

body diameter may be made at the bourrelet, obturator location non-inclusive of obturator, and rear end of the body, or alternatively at other locations considered critical.

8. Visual Examination before Firing. Visual examination of each mortar bomb is to be made for damage and for misalignment of fins. Mortar bombs so damaged as to affect assessment of deformation after firing are to be rejected for test purposes.

9. Conditioning Times. Minimum conditioning times to be used in relation to the mortar bomb calibre and the required temperature are given below:

		Conditioning Durations (hours) for each Temperature Range		
Serial	Calibre	Below -30°C	-30°C to -10°C and above 50°C	-9°C to 50°C
1	120 mm and above	48	36	24
2	75 mm to 119 mm	32	24	16
3	35 mm to 74 mm	24	18	12

Table 1

10. Sub-Samples. A sub-sample of 15 bombs is to undergo hot conditioning and firing and a second, similar sub-sample is to undergo cold conditioning and firing.

11. First Sub-Sample.

a. The sub-sample is to be conditioned to the UFT.

b. A special propellant charge is fitted to the sub-sample mortar bombs which is designed to give the mortar bomb under test a level of pressure equivalent to the value of MOP (Sub-paragraph 2.a. above) plus 5%.

c. Mortar bombs (additional to the sub-sample) should be fired in order to warm the barrel of the test mortar.

d. The sub-sample is to be fired at the UFT for recovery.

12. Second Sub-Sample.

a. The second sub-sample is to be conditioned to the LFT.

b. A special propellant charge is fitted to the sub-sample mortar bombs which is designed to give the mortar bomb under test a level of pressure equivalent to a theoretical LFT MOP plus 5%. This MOP is derived by adding 3 standard deviations to the LFT mean value of maximum pressure (see Sub-paragraph 2.b. above).

c. The sub-sample is to be fired at the LFT for recovery.

13. Records and Observations. The following are required:

a. Maximum pressure of each mortar bomb fired.

b. Muzzle velocity of each mortar bomb fired.

c. A high-speed photographic record of each mortar bomb as it leaves the muzzle.

d. Measurement and inspection of each mortar bomb recovered after firing, as detailed in Paragraphs 14 and 15 below.

14. Measurements After Firing. Measurements made before firing (Paragraph 7 above) are to be repeated after firing and recovery, at the same measurement locations on each mortar bomb as were used for measurements before firing.

15. Examination After Firing. Mortar bomb bodies and tail assemblies will be examined visually and radiographically if possible, for cracks or other evidence of failure. Photographic records of damage will be made. Damage which is clearly attributable to impact should be recorded separately.

16. Criteria. Maximum pressures and muzzle velocities recorded on firings must show, that for the mortar bomb weight fired, the required test conditions were met. Mortar bombs will be considered to have met the requirements for strength of design between the stated UFT and LFT limits if the following criteria are met:

a. There must be no evidence of mortar bomb break-up, cracks in metal structures, or any other failure which is attributable to launch.

b. Corresponding measurements before and after firing must not differ by more than can be attributed to instrumental error, or must be within the limits prescribed in the Technical Specification when applicable.

FREEDOM FROM PREMATURE AND EARLY BURST TRIAL

AIM

1. The aim of the Freedom from Premature and Early Burst Trial is to determine whether mortar bombs in conjunction with their fuzes are safe to fire, safe in-flight, and function safely after being subjected to a simulated serice environment.

PRE-REQUISITE TESTING

2. It is desirable that this trial should be carried out at PMP pressures, but the use of pressures based on the calculated MOP alue is the minimum requirement and is the level quoted in the text. The following trials should have been completed with satisfactory results before this trial can proceed:

a. Safety of Propellant Trial (Annex A).

b. Strength of Design Trial (Annex B).

c. Safety Evaluation of Fuze (STANAG 4157).

TRIAL PLAN

3. The trial objectives are as follows:

a. To subject the mortar bombs and fuzes to a series of sequential environmental tests to simulate a severe combination of service conditions, which might be encountered before the mortar bomb is fired operationally.

b. To check on bore safety, the safety in flight and safe functioning of the mortar bomb and fuze in combination, after exposure to the simulated service environment.

4. Each combination of fuze and mortar bomb will be subjected to the sequential tests as shown in Table 1 below. The first 2 tests are carried out with mortar bombs in both inner containers (single, duplex or other tubes) and outer packaging (metal or wooden boxes). Thereafter tests are carried out with inner containers only or unpackaged as indicated. Sample sizes quoted are the minimum numbers required.

5. Each test represents a possible condition experienced by mortar bombs in service. Where no STANAG exists to govern the detailed test conditions, tests may be carried out in accordance with national standards, which must be recorded in test reports, providing that these conform to the general parameters specified in this Annex.

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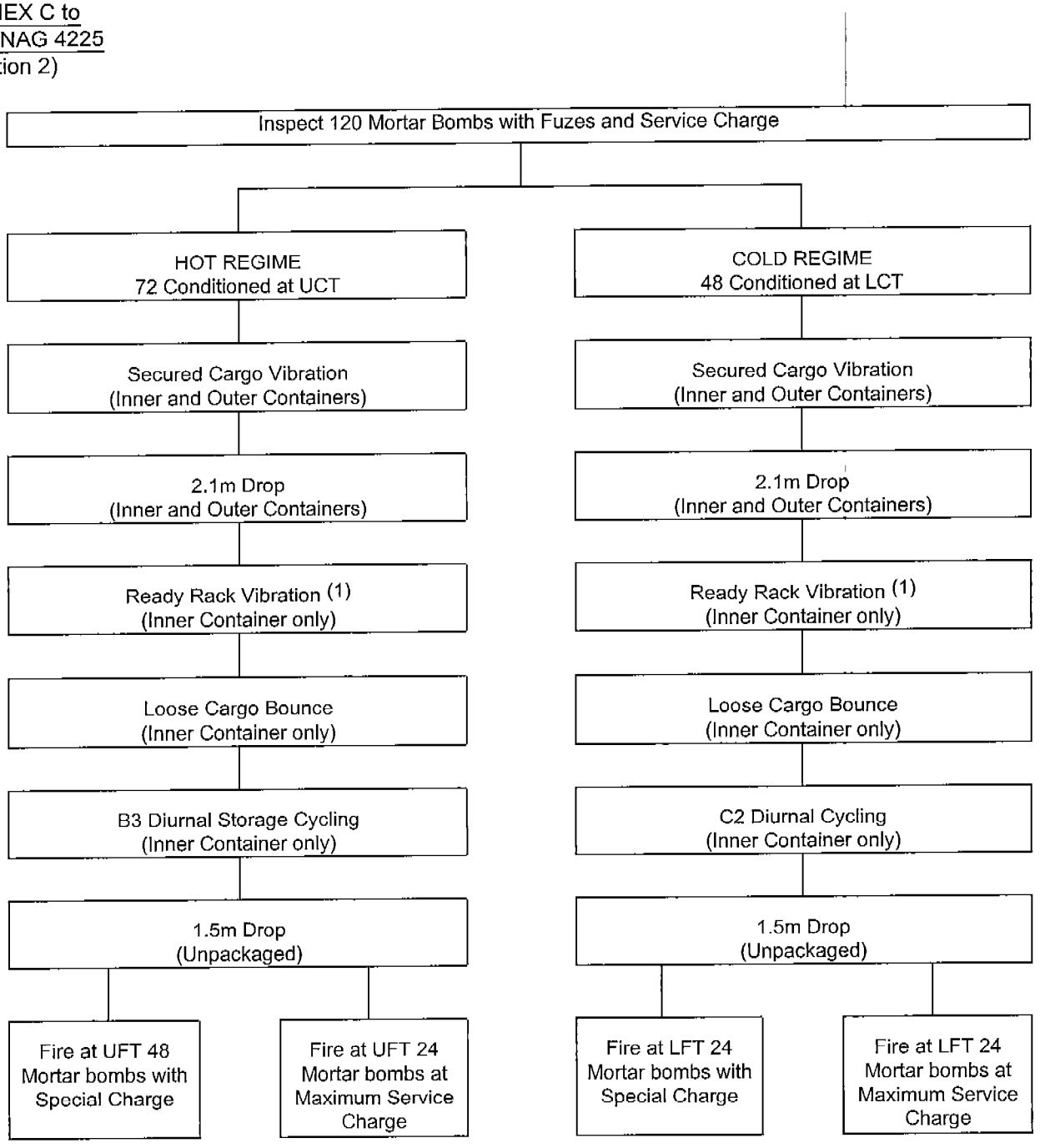

Table 1 : Outline Trial Plan - Freedom from Premature and Early Burst Trial

1 This test is only to be carried out when the mortar bombs under test are to be stored in special racks in mortar vehicles when in service

6. Sample. A minimum of 120 service filled mortar bombs, together with the appropriate fuze and service charge, are required for this trial. After initial inspection the sample will be divided into 2 sub-samples. Seventy-two mortar bombs in the first sub-sample will follow the Hot Regime, and 48 in the second sub-sample will follow the Cold Regime. These figures represent an absolute minimum number which must follow the full series of sequential tests and be fired in accordance with Paragraph 10 below. It is envisaged that some nations may wish to use additional rounds to carry out firings after some or each of the environmental tests, or in order to have sufficient numbers to meet national standards for carrying out certain of the environmental tests.

7. Sequential Testing. Details of the Hot and Cold Regimes are given in Paragraphs 8 and 9. The following general points are applicable to both:

a. **Initial Inspection**. At the start of the trial all mortar bombs will be inspected. This will include:

(1) Visual Inspection for Defects.

(2) Record of Lot Numbers.

(3) Establish Identification of Mortar Bombs.

(4) Weight of Projectiles as fired.

(5) Weight of Propellant Charge.

(6) Radiography of Mortar Bombs and Fuzes.

b. **Conditioning**. Conditioning for the Hot Regime is to be at the service UCT. Conditioning for the Cold Regime is to be at the service LCT. Conditioning times are to be in accordance with the guidelines given at Paragraph 9 of Annex B.

c. **Inspection between Tests**. All mortar bombs, including fuzes, propellant charges, and packaging, where appropriate, are to be inspected after each stage of the sequential testing, in order to determine the effects of each environmental test. Records of these inspections will be required in order to assist subsequent assessment. Tests will not be allowed to proceed if there is any evidence from these inspections that a hazardous condition exists. If this occurs, a further assessment will be made as to whether the mortar bomb in this condition is safe for normal disposal, ie can be handled and removed to a suitable location for disposal.

d. **Propellant Charges**. Special charges are required for firing a certain number of mortar bombs at the end of each regime. This is in order to test the mortar bombs against the highest pressures which might occur in service. In the Hot Regime 48 Special Charges are required for firing at the UFT, which when fired at that temperature will produce a pressure equivalent to the MOP calculated from the Safety of Propellant Trial at Annex A. In the Cold Regime 24 Special Charges are required for firing at the LFT, which will produce, at that temperature, a pressure equivalent to the LFT MOP. (These charges are similar to those required for the Strength of Design Trial at Paragraph 3 of Annex B, but are different in that they are equivalent to MOP rather than MOP plus 5%).

e. **Records and Observations**. For each bomb fired, the following observations are to be recorded:

(1) Barrel pressure against time curve.

(2) Muzzle velocity.

(3) Smear camera record in instances of irregular flight.

(4) Fuze functioning (and burst height where appropriate).

(5) Range and deflection of impact.

(6) Complete inspection data.

8. First Sub-Sample (Hot Regime).

a. **Secured Cargo Vibration/Ready Rack Vibration.**

(1) After inspection, mortar bombs and fuzes are identified by serial numbers and packed in inner and outer containers as appropriate.

(2) Containers and mortar bombs are conditioned to the service UCT.

(3) Containers and mortar bombs are vibrated in each of 2 axes at the conditioning temperature. The duration of testing and vibration sequence will be in accordance with the relevant national standard appropriate to the secured cargo environment. Test parameters used will be recorded and reported. Appropriate STANAGS will be followed when published.

(4) After inspection, mortar bombs are passed in appropriate packaging to the next stage of testing as per Table 1.

(5) Where mortar bombs are to be carried in both tracked and wheeled vehicles, the level appropriate to tracked vehicles should be used in testing.

(6) Where mortar bombs are to be carried in vehicle racking in inner containers, or unpackaged, the test is to be carried out with the bombs in the appropriate packaging and racking. The racked storage vibration test need not be carried out for mortar bombs which are not intended for carriage in this manner.

b. **2.1 m Drop Test.**

(1) Mortar bombs in inner and outer containers from the preceding test (Table 1) are reconditioned to the service UCT.

(2) Mortar bombs in inner and outer containers are dropped in each of 2 orientations through a height of 2.1 m in accordance with the relevant national standard, or appropriate STANAG when published.

(3) After inspection, mortar bombs are passed in appropriate containers to the next stage of testing as per Table 1.

c. **Loose Cargo Bounce Test.**

(1) Mortar bombs in inner containers from the preceding test (Table 1) are reconditioned to the service UCT.

(2) Mortar bombs in inner containers are subjected to testing representative of transportation as loose cargo in service wheeled vehicles, in accordance with the relevant national standard, or appropriate STANAG when published.

(3) After inspection, mortar bombs are passed to the next stage of testing as per Table 1.

d. **Diurnal Storage Cycling.**

(1) Mortar bombs from the preceding test (Table 1) are reconditioned to +33EC.

(2) The mortar bombs are subjected to 7 days of B3 Diurnal Storage Cycling according to STANAG 2895 in their inner containers.

(3) After inspection, mortar bombs are passed to the next stage of testing.

e. **1.5 m Drop Test.**

(1) Unpackaged mortar bombs from the preceding test (Table 1) are reconditioned to the service UCT.

(2) Unpackaged mortar bombs are dropped through a height of 1.5m once each in one of the following 5 orientations:

(a) Major axis horizontal.

(b) Base down.

(c) Nose down.

(d) Major axis 800 mils from vertical, base down.

(e) Major axis 800 mils from vertical, nose down.

(3) After inspection all mortar bombs adjudged safe for firing are fired in accordance with Paragraph 10 below.

9. Second Sub-Sample (Cold Regime). The procedure detailed for the first Sub-Sample in Paragraph 8 above is repeated for the second Sub-Sample with the following exceptions:

a. Conditioning is in all instances carried out to the service LCT, except that -37°C should be used for the start of diurnal cycling.

b. B3 Diurnal Cycling under Sub-paragraph 8.d. is replaced by C2 Diurnal Cycling.

10. Firing Test. For the firing test each sub-sample will be further divided and fired as follows:

a. **Maximum Service Charge**. A total of 48 serviceable mortar bombs, with serviceable propellant charges are to be fired with the maximum charge. Some damage to augmenting charges may have occurred during the sequential environmental tests and should be replaced with charges from other bombs that have also completed the environmental tests. A total of 24 bombs are to be fired at the appropriate UFT and 24 at the LFT.

b. **Special Charge**. The remaining mortar bombs in each sub-sample are then fitted with the appropriate Special Charge (see Sub-Paragraph 7.d. above), which will not have been subjected to the sequential environmental tests and fired at the appropriate UFT and LFT.

11. Criteria. Mortar bomb and combinations will be considered to have met the requirements of this trial if the following criteria are met:

c. No hazardous circumstance occurs during sequential environmental testing, and if any bombs are found to be defective after testing, they are safe for normal disposal.

d. No mortar bomb detonates in any of the following circumstances:

(1) On firing.

(2) In the bore.

(3) During subsequent flight without activation by the fuze.

(4) Due to fuze action before the predicted point of flight.

OTHER MANDATORY SAFETY TRIALS

INTRODUCTION

1. There are 2 mandatory trials which must be carried out to complete the safety evaluation:

   a. **Cook-off Trial.**

   b. **Safety Drop Trial (12m).** Details of the Safety Drop Trial are in STANAG 4375.

COOK-OFF TRIAL

2. Aim. To determine the temperature at which cook-off is likely to occur, and the time taken for cook-off at this temperature.

3. Trial Plan. This trial may be conducted in conjunction with other functioning trials to establish rapid rates of fire. The trial will be conducted using the hot barrels at the conclusion of such firings. Simulated misfires will be loaded into hot barrels at varying temperatures, achieved by natural barrel cooling, to determine the temperatures associated with cook-off and the time taken to cook-off. Alternatively, if available, a system for artificially heating barrels may be used.

4. Ammunition. In order to simulate a misfire, ammunition will be prepared without igniter cartridges. For mortars without fixed firing pins, this will not be necessary, since a misfire can be simulated simply by not firing. Inert filled bombs will be used, fitted with the largest incremental charge.

5. Test Details.

   a. Barrels will be instrumented to measure bore temperature.

   b. After firing the maximum service rate of fire, barrel temperature will be monitored.

   c. A simulated misfire is loaded into the hot barrel and time taken to cook-off is recorded, together with associated barrel temperature. If cook-off occurs a second simulated misfire is loaded.

   d. The test continues until cook-off does not occur. Two temperatures are then established, one at which cook-off occurs, and a lower temperature at which cook-off does not occur. Further tests should then be conducted, using another hot barrel, within those temperature limits in order to narrow the gap between these 2 figures.

   e. The test will continue in this manner until results from 10 rounds are obtained of which at least 5 have cooked off, (unless the trial shows that at the hottest temperatures attainable in service use the ammunition will not cook-off) and sufficient data is available to indicate the temperature below which cook-off will not occur.

6. Assessment. From the results recorded it will be possible to determine the temperature at which mortar bombs are liable to cook-off and the time in which cook-off can be expected to occur.

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MORTAR AMMUNITION DOUBLE LOADING TEST (Non Mandatory)

AIM

1. The aim of this test is to determine, in the event of double loading:

   a. For each charge level, the pressure generated in order to determine at what charge level any specific mortar barrel's PMP is likely to be exceeded.

   b. Whether the HE filling is likely to contribute to the effect of an incident.

PRE-REQUISITE TESTING

2. The mortar PMP curve, established by the weapon developer, is required.

3. The following trials should have been completed, with satisfactory results, before this trial can proceed.

   a. Safety of Propellant Trial (Annex A).

   b. Strength of Design Trial (Annex B).

   c. Freedom from Premature and Early Burst Trial (Annex C).

   d. Appropriate STANAG 4157 fuze safety tests.

OUTLINE TRIAL PLAN

4. Part 1 - Pressures Generated by Charges.

   a. **Mortar Bombs**. Inert filled mortar bombs should be used which are assembled in accordance with the technical specification. Bombs are to be fitted with inert fuzes. The inert charges inside the projectiles and fuzes must simulate the weight, density and mechanical properties of the explosives they replace. It is essential that the locking torques of the screwed assemblies and the seals are to specification. No round or fuze should be subjected to more than one test.

   b. **Charges**. All service charges are to be available.

   c. **Mortar**. A pressure barrel capable of withstanding up to 6 times the PMP of a standard service barrel should be used. It should be capable of being fired remotely in the horizontal position. It should be fitted with instrumentation to measure pressure at 2 or 4 points:

      (1) At the base of the first round (Mandatory).

      (2) At the base of the second round (Mandatory).

      (3) Just below the obturation ring of each round (Optional).

   d. **Witness Screens**. Witness screens representing the crew at the moment of firing should be positioned at appropriate representative locations.

   e. **Temperature**. Firings are to be carried out with bombs at ambient temperature and conditioned at the UFT and at the LFT.

f. **Occasions**. The test is to be repeated 12 times, or until 7 useable results are obtained at each charge and for each temperature. Maximum charges are to be tested first, followed by subsequent lower charges in descending order. If no pressure barrel is available to conduct the trial, charges may be fired in ascending order.

g. **Test Procedure** (see Figure 1).

(1) Round Number 1, with the selected charge fitted, is placed at the bottom of the test barrel which is then lowered into a horizontal position. Round Number 2 is placed in contact with the first round.

(2) Round Number 1 is fired remotely.

(3) Both rounds are recovered and examined for damage or penetration of gasses at joints in the body.

(4) The test is repeated as defined in Paragraph 4f above.

(5) The test is to be stopped at the charge for which the pressures recorded are equal, or just below, the mortar PMP.

(6) Equipment is to be checked between each test series and during tests if any anomaly is found. The barrel is to be checked before each firing to ensure it is clear of potential obstructions.

(7) The test should be stopped immediately if there is evidence of:

(a) Rupturing of the projectile body.

(b) Ingress of gas into the body.

(c) Impacts on the witness screen likely to represent potential for serious wounds to members of the mortar crew.

h. **Records and Observations**. The following are required:

(1) Specifications of weapons and ammunition.

(2) Pressures measured at each measuring point (against time).

(3) Calculation of mean pressures and standard deviations.

(4) Details of damage to rounds and evidence of ingress of gas into the body through relevant joints.

(5) Evidence of significant impact on the witness screen.

5. Part 2 - Influence of HE Filling (see Figure 1). This test is only to be undertaken if no defects attributable to the design of the round were identified in Part 1.

a. **Mortar Bombs**. For each firing one inert filled bomb, as described in Paragraph 4.a., is required and one live bomb. Both bombs are to be fitted with inert fuzes. The qualifications itemised at Paragraph 4.a. also apply.

b. **Charges**. Maximum charge allowed by Part 1 Test, ie equal to or just below mortar PMP.

c. **Mortar**. A mortar as described in Paragraph 4.c. should be used.

d. **Witness Screens**. Witness screens, as specified in Paragraph 4d, should be provided.

e. **Temperature**. Firings are to be carried out at ambient, UFT and LFT.

f. Occasions. The test is to be carried out 3 times at each temperature.

g. **Test Procedure.**

(1) Round Number 1, with the maximum charge allowed by the Part 1 Test fitted, is placed at the bottom of the test barrel which is then lowered into a horizontal position. Round Number 2 is placed in contact with the first round.

(2) Round Number 1 is fired remotely.

(3) The test is to be stopped immediately if there is evidence of:

(a) Any detonation, initiation or combustion of the live projectile filling.

(b) (Overpressures considered abnormally higher than that recorded during Part 1.

(c) Impacts on the witness screen likely to represent potential for serious wounds to members of the mortar crew.

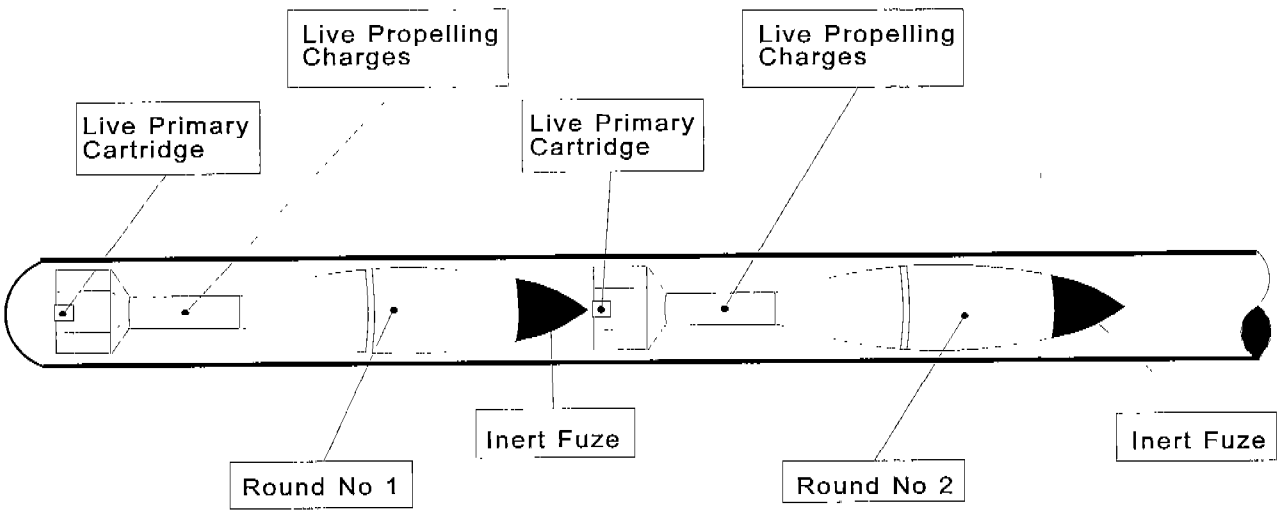
h. **Records and Observations**. The following are required:

(1) Pressures measured at each measuring point.

(2) Details of damage to rounds and evidence of ingress of gas into the body through relevant joints.

(3) Evidence of significant impact on the witness screens.

(4) Evidence of any detonation, ignition or combustion of the live projectile filling.



	Round Number 1			Round Number 2		
Test	Charge	Filling	Fuze	Charge	Filling	Fuze
Part 1	Live	Inert	Inert	Live	Inert	nert
Part 2	Live	Live	Inert	Live	Inert	Inert

Figure 1

6. Part 3 - Live Test. A final test may be undertaken at the discretion of nations to assess the potential hazards in the event of double loading incident in the worst case.

a. **Mortar Bombs**. For each firing, 2 live mortar bombs are required, both fitted with live fuzes and charges.

b. **Charges**. Firings are to be with maximum charge fitted to both bombs.

c. **Mortar**. A pressure barrel, as specified in paragraph 4c, is to be used set-up with an elevation of greater than 1067 mils (60°).

d. **Witness Screens**. Witness screens are to be provided as described at Paragraph 4c.

e. **Recording Equipment**. The following recording equipment is to be used:

(1) Flash X-ray aligned with the muzzle.

(2) High-speed video recorder.

f. **Temperature Conditioning**. For each firing, both bombs are to be conditioned to either the UFT or the LFT.

g. **Occasions**. The test is to be carried out on 2 occasions, once each with bombs conditioned at each temperature.

h. **Test Procedure**.

(1) Round Number 1, with the charge fitted, is placed at the bottom of the test barrel. Round Number 2, also with the charge fitted is inserted into the barrel so that it is in contact with the first round. The barrel is then set at an elevation of greater than 1067 mils (60°).

(2) Round Number 1 is fired remotely.

(3) Any bomb which is expelled from the barrel is to be located and, if a blind, destroyed.

i. **Records and Observations**. The following observations are to be recorded:

(1) Specifications of weapons and ammunition.

(2) Pressures measured at each measuring point.

(3) Functioning of the bombs, either in the barrel, in flight or on impact with the ground.

(4) The location, in terms of range and bearing from the firing point, of bomb impact.

(5) Evidence of significant impact on the witness screens.

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RATIFICATION AND IMPLEMENTATION DETAILS
STADE DE RATIFICATION ET DE MISE EN APPLICATION

NATION / PAYS	NATIONAL RATIFICATION REFERENCE REFERENCE DE LA RATIFICATION NATIONALE	NATIONAL IMPLEMENTING DOCUMENT DOCUMENT NATIONAL DE MISE EN APPLICATION	IMPLEMENTATION/MISE EN APPLICATION					
			INTENDED DATE OF IMPLEMENTATION DATE ENVISAGEE DE MISE EN APPLICATION			DATE IMPLEMENTATION WAS ACHIEVED DATE EFFECTIVE DE MISE EN APPLICATION		
			NAVY MER	ARMY TERRE	AIR	NAVY MER	ARMY TERRE	AIR
BE								
CA	2441-4225 (DAPM 4-3) of/du 06.10.00	STANAG	12.00	12.00	12.00			
CZ	6/2-18/2000-1419 of/du 26.07.00			12.05	12.05			
DA*	FKO-MAM3 204.69-S4225 9904988-004 of/du 18.06.99		12.01	12.01	12.01			
FR*	DGA/GSA 001264 of/du 15.09.99	STANAG	10.99	10.99	10.99			
GE	BMVg-Fü S IV 1 - Az 03-51-60 of/du 13.10.99		12.01	12.01	12.01			
GR								
HU								
IT								
LU								
NL								
NO								
PL								
PO								
SP								
TU								
UK	12/15/4225 of/du 14.06.99	STANAG	12.01	12.01	12.01			
US*	OUSD(A&T) of/du 12.06.00	(ITOP) 4-2-504(3)	06.00	06.00	06.00	06.00	06.00	06.00

* See overleaf reservations/Voir réserves au verso
\+ See comments overleaf/Voir commentaires au verso

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RESERVATIONS/RESERVES

DENMARK

The Danish army will implement the requirements of STANAG 4225 for newly developed or modified mortar munitions, that have not previously been in the Danish army inventory, and for modification of mortar munitions initiated after implementation.
STANAG 4225 mentions fall-of-shot recording, e.g. in para 6l, para 6k(4) and 6m(4), including shot range and deflection.
The Danish army reserves the right to use radar tracking of shots to obtain these data, as this method, in Danish army experience, is both accurate and viable. For any future revision of STANAG 4225, the Danish army recommends, that radar tracking of shots during test is detailed in the STANAG as a viable measuring method.

DANEMARK

Les forces terrestres danoises mettront en application les prescriptions du STANAG 4225 pour les munitions de mortier de conception nouvelle ou modifiée qui n'ont pas encore figuré dans leur inventaire, et pour celles dons la modification est intervenue après la mise en application. Il est fait mention dans le STANAG 4225, notamment aux paragraphes 6l, 6k(4) et 6m(4), de l'enregistrement des points de chute, y compris la dérive et la distance. Les forces terrestres danoises se réservent le droit, pour obtenir les données de point de chute, d'utiliser la méthode de la poursuite radar qui, d'après leur expérience, est à la fois précise et fiable. Les forces terrestres danoises recommandent, lors de toute révision ultérieure du STANAG, d'y faire figurer en détail la méthode de poursuite radar des poins de chute dans les essais comme méthode de mesure fiable.

FRANCE

France reserves the right, for its own programmes, to modify the quantities of shells subjected to the tests depending on the results already obtained in testing during development

FRANCE

La France se réserve le droit, pour ses propres programmes, de modifier les quantités d'obus sousmis aux essais en fonction des résultats déjà acquis lors des essais menés au cours du développement

UNITED STATES.

1. The US will not comply with the proposed test for wet efficiency trials.
2. The US will not comply with the Outline Test Plan as depicted in Table 1.

ETATS-UNIS

1. *Les Etats-Unis ne se conformeront pas aux critères d'essai proposés pour les épreuves de résistance à l'humidité.*
2. *Les Etats-Unis ne se conformeront pas au schéma du plan d'essai qui figure au tableau 1.*